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Great Lakes Update

Current Great Lakes Studies

Two key studies are either underway or being designed to assess potential improvements to regulation of Lakes Superior and Ontario outflows. This update article is written to give our broad readership a summary of the status of on-going deliberations on the management of these precious natural resources. A brief history of outflow regulation for these two lakes is also presented. Finally, a series of questions and answers on water level issues are also provided in this article.

Although it is customary to discuss the Great Lakes from the headwaters downstream (Lake Superior through Michigan, Huron, St. Clair, Erie and Ontario), this article will discuss Lake Ontario studies first since they have been officially underway since Fall 2000.

History and Background of Lake Ontario Outflow Regulation

Development of the upper St. Lawrence River for navigation and hydropower was proposed as early as 1825. However, the most significant events associated with this development occurred in the early 20th century. Figure 1 shows a map of the St. Lawrence River system.

The International Waterways Commission was established in December 1903 by the governments of Canada and the United States to establish a guiding set of principles and resolve disputes in boundary waters. This led directly to the Boundary Waters Treaty of 1909 between the U.S. and Great Britain. This treaty established the present International Joint Commission (IJC), which guides the regulation of Lakes Superior and Ontario.

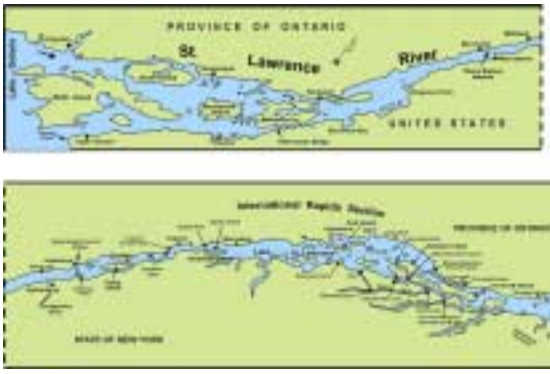

Figure 1: St. Lawrence River

The Boundary Waters Treaty of 1909 specified that navigation "shall forever continue free and open for the purposes of commerce" and that the navigation laws of one country were to apply to citizens and vessels of the other.

Although navigation was stressed, as population and industry expanded, interest in the development of electricity began to appear. The rapids of the river could facilitate this development. The dual purpose of a St. Lawrence River Seaway project was substantiated by a 1921 study by the U.S. Army Corps of Engineers and the Department of

Railways and Canals of Canada, under the auspices of the IJC. After additional study, reporting, and discussion, the Corps submitted a report titled "St. Lawrence River Project, Final Report, 1942." This document formed the basis for the planning and construction of the present Seaway in the 1950's.

The IJC approved the project in 1952. During construction, the IJC amended its Orders of Approval, the legal description of its directives to the Board of Control, with the concurrence of the United States and Canadian Governments. The 1956 amendments added requirements to reduce the range of Lake Ontario water levels, and to provide dependable flow for hydropower, adequate navigation depths, and protection for shoreline and other interests downstream in the Province of Quebec.

One requirement in the IJC's Orders was to regulate Lake Ontario within a target range from 74.2 to 75.4 meters (243.3 to 247.3 feet), IGLD 1985, above sea level. The project must also be operated to provide no less protection for navigation and shoreline interests downstream than would exist without the project.

Another provision in the Orders, known as criterion (k), was included because water supplies would inevitably be more extreme some time in the future than in the past (1860-1954). When supplies exceed those of the past, shoreline property owners upstream and downstream are to be given all possible relief. When water supplies are less than those of the past are, all possible relief is to be provided to navigation and power interests.

St. Lawrence River Board of Control

In its 1952 Orders of Approval, the IJC established the International St. Lawrence River Board of Control. This Board's main duty is to ensure that outflows from Lake Ontario meet the requirements of the IJC's Orders. The Board also develops regulation plans and conducts special studies, as requested by the IJC.

The Board sets outflows under the regulation plan or under criterion (k) once it has been invoked by the IJC. The Board may deviate from plan flows under emergency conditions or winter operations. It may also use its limited discretionary authority when a change from plan flow can be made to provide benefits or relief to one or more interests without appreciably harming others, and without breaching the requirements of the Orders. The Board meets at least twice annually and provides semi-annual reports to the IJC. It also holds meetings with the public annually.

The International St. Lawrence River Board of Control has ten members, five each from the U.S. and Canada. The current U.S. chairperson is from the U.S. Army Corps of Engineers, while the other U.S. members are from the New York Power Authority, the New York State Department of Environmental Conservation and the Rochester Institute of Technology, along with one independent engineer.

The current Canadian chairperson is from the Canadian Coast Guard, while the other Canadian members are from Ontario Power Generation, the Quebec Ministry of Environment and Environment Canada, as well as the mayor of a downstream community. To assist the Board, each nation has a secretary and a regulation representative. The regulation representatives provide technical support to the Board. The Board also has an Operations Advisory Group, consisting of navigation and hydropower representatives, which recommend weekly outflows for approval by the Board.

Regulatory Facilities

Lake Ontario outflows have been regulated since 1960, primarily through the Moses-Saunders power dam near Cornwall and Massena, about 160 kilometers (100 miles) from the lake (Figure 2). This facility is jointly owned and operated by Ontario Hydro and the New York Power Authority.

Figure 2: Moses Saunders Hydropower Dam

Another dam, located near Long Sault, Ontario, acts as a spillway when outflows are larger than the capacity of the power dam. A third structure at Iroquois, Ontario, is principally used to help to form a stable ice cover and regulate water levels at the power dam.

The IJC does not supervise the other projects in the St. Lawrence River. These include three navigation locks in the international section of the St. Lawrence River, two at Massena and one at Iroquois, Ontario, as well as hydropower and navigation facilities downstream in the Province of Quebec.

Additional information on the regulation of Lake Ontario can be found on the Internet at the following address: http://www.islrbc.org/new-Version/brochure.html; and in the October 1, 1991 Update Letter No. 75 "Lake Ontario Regulation" available by mail on request.

International Lake Ontario – St. Lawrence River Study

The International Lake Ontario – St. Lawrence River Study was set in motion in 2000 by the IJC to examine the effects of water level and flow variations on all interest groups and determine if better regulation were possible at the existing structures controlling Lake Ontario outflows. This study is to be completed within five years.

The objectives of the Study are to identify and evaluate how changes to current Lake Ontario regulation will affect the interests of various users, while ensuring that any suggested changes are consistent with relevant treaties and agreements between nations.

The Study will not examine structural changes to the existing authorized control works that make Lake Ontario outflow regulation possible. Rather, priority will be on the identification of other measures to alleviate adverse impacts of water level and flow fluctuations.

A Study Board has been created with 15 members representing U.S. and Canadian federal, provincial and state governments, first nations, academic institutions and concerned citizenry. The Study also has developed a 21-member Public Information Advisory Group (PIAG) to provide oversight and public outreach throughout the study process.

The Study team also includes experts comprised into eight Technical Work Groups (TWGs), who have developed detailed study plans, which are to be approved by the Study Board. These TWGs focus on the following areas:

- Coastal Zone
- Commercial Navigation
- Common Data Needs
- Environment
- Hydrology and Hydraulics Modeling
- Water Use
- Hydroelectric Power Generation
- Recreational Boating and Tourism

The International Lake Ontario – St. Lawrence River Study plans to conduct periodic public meetings to present status reports and preliminary findings. For further information on the Study, please visit its Internet web site at: http://www.losl.org or contact the IJC staff at 613-992-5727.

History and Background on Lake Superior Outflow Control

Water flows out of Lake Superior into Lake Huron through the St. Marys River. The St. Marys River falls about 20 feet in a distance of 0.75 mile as it passes through the St. Marys Rapids near the cities of Sault Ste. Marie, Michigan and Ontario. Since 1797, when the first lock was built to allow boats to bypass these rapids, the St. Marys River has undergone many physical changes to both harness its energy and to allow the passage of vessels. Over the years the construction of bridges, hydropower plants, navigation locks, and a gated control structure have made it possible to control the flow in the river and thus the outflow from Lake Superior. See Figure 3 for an aerial view of the St. Marys River and Rapids area.

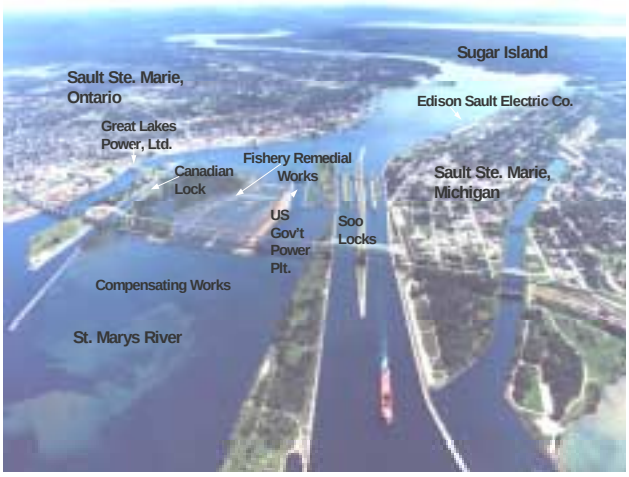

Figure 3: Aerial view of St. Marys River and Rapids Area

Today, the water from Lake Superior flows through a series of structures that stretch across the river. These works include three hydropower plants, five navigation locks, and a 1,000-foot-long dam with sixteen vertical lift gates at the head of the rapids known as the Compensating Works (Figure 4).

This structure is owned half by Canada and half by the U.S. government. The release of water from Lake Superior through the various

Figure 4: Compensating Works

structures has been completely regulated since the completion of the Compensating Works in 1921. The Fishery Remedial Works is a 2,800-foot long dike designed to retain a sufficient flow of water along the south bank of Whitefish Island to approximate previous natural conditions in that area of the rapids. It was completed in 1985. Water to the remedial works is provided through Gate No. 1 on the Canadian side of the Compensating Works.

Lake Superior Board of Control

The Boundary Waters Treaty of 1909 gave responsibility for regulation of Lake Superior's outflow to the IJC. In its 1914 Orders of Approval, which allowed increased hydropower development in the St. Marys River and established the basic objectives for and limits to the regulation of Lake Superior's outflow, the IJC acknowledged the needs of various interest groups on Lake Superior and the St. Marys River, including navigation, hydropower and riparian owners.

The 1914 Orders also established the International Lake Superior Board of Control. This Board is charged with overseeing the supervision of operation and maintenance of the Compensating Works, power canals, and all appurtenances on the St. Marys River at Sault Ste. Marie, Michigan and Ontario with a view to

controlling the outflow from Lake Superior, in accordance with the provisions of the IJC's Orders of Approval.

The Board has two members, one each from Canada and the United States. Each section has a Secretary, Regulation Representative and On-Site Representative to assist in carrying out Board directives.

Since 1978, the IJC has issued several supplements to the original Orders of Approval. As a result, the Orders now specify that the level of Lakes Michigan and Huron must also be considered when determining the outflow from Lake Superior. In addition, the Orders address concerns for the fishery in the rapids.

Since 1916, seven different regulation plans have been developed and used to determine Lake Superior outflows. Each of these plans has adhered to the operating conditions contained in the IJC's Orders. The main objective of the present regulation plan, Plan 1977-A, is the determination of flows that will bring the levels of Lake Superior and Lakes Michigan and Huron to nearly the same relative position within their respective ranges of actual historic levels.

At the same time, the plan tries to prevent the level of Lake Superior from rising above or falling below certain water levels specified in the Orders. The plan also contains provisions to safeguard against high levels in the harbor below the locks, provides a fixed minimum release, limits winter flows, and employs a forecast of future water supply conditions.

The ability to regulate the outflows from Lake Superior does not mean that full control of lake levels is possible. This is because the major factors affecting the water supply to the Great Lakes -- over-lake precipitation, evaporation and runoff -- cannot be controlled; neither can they be accurately predicted over the long term.

The regulated release of water from Lake Superior is made through various structures located on the St. Marys River. The allocation of flow to these facilities is determined monthly, based on the outflow specified by the regulation plan and the conditions given in the Orders of Approval. This water is used for domestic water supply, navigation through the locks, hydropower production, and to maintain fish habitat in the rapids.

After navigation, domestic water, and fish habitat needs are met the remainder of the allocated outflow is split 50/50 between the U.S. and Canadian hydropower plants. If the outflow determined by the regulation plan exceed these needs, additional gates are opened at the Compensating Works to allow passage of the total specified outflow.

Additional information on the regulation of Lake Superior can be found on the Internet at: http://huron.lre.usace.army.mil/ijc/lsbrespon.html; and by downloading the December 1, 1993 Update Letter No. 101 "The Regulation of the Outflow from Lake Superior" located at: http://huron.lre.usace.army.mil/updates/.

Upper Great Lakes Plan of Study

The IJC recently appointed an Upper Great Lakes Plan of Study Team to prepare a plan for reviewing the regulation of the flow of water out of Lake Superior. Regulation affects water levels and flows – and consequently a variety of interests – in the upper Great Lakes system from Lake Superior downstream through Lake Erie.

The review will assess whether changes to regulation are warranted to meet contemporary and emerging needs, and interests and preferences for managing the system in a sustainable manner, including management under climate change scenarios. The plan will address potential impacts on the environment, recreational boating, commercial navigation, hydropower, water use, and the coastal zone.

The Plan of Study Team will prepare a draft Plan of Study by October 18, 2001. The draft will be posted on the web and mailed to interested parties, who will be asked to provide comments. In addition, the Team will hold a series of public consultation meetings to discuss elements of the plan and solicit feedback. The meetings are planned for the following dates and locations:

October 31 – Duluth, Minnesota
November 1 – Thunder Bay, Ontario
November 5 – Sault Ste. Marie, Ontario
November 6 – Muskegon, Michigan
November 7 – Milwaukee, Wisconsin
November 13 – Parry Sound, Ontario
November 14 – St. Clair Shores, Michigan
November 15 – Cleveland, Ohio

Directions to the location of all meetings and other information on the Plan of Study can be found on the Team's Internet website at: http://huron.lre.usace.army.mil/ijc/uglpos/, or by calling the U.S. Army Corps of Engineers at 313-226-6440.

Following public consultation on the draft Plan of Study, the team will provide a final plan to the IJC in January, 2002. The actual review of regulation would not be initiated until funds were appropriated by the Governments of the United States and Canada for activities outlined in the Plan of Study.

Frequently Asked Questions

With all the rain experienced recently in some areas of the Great Lakes, why don't the water levels rise more, if at all?

Several factors are involved in influencing the behavior of the water levels of the Great Lakes. Although precipitation, evaporation and outflows are three major components that affect water levels, other factors can play a significant role in the total water supply to a lake.

First, the surface area of the Great Lakes is over 95,000 square miles – the largest chain of lakes in the world. The quantity of rain required for these lakes to respond significantly must be spread across vast areas of their drainage basins or on their lake surfaces, with the only exception being Lake St. Clair, a relatively small domain.

Much of the heavy rainfall that has been experienced recently has been localized. For example, Chicago received over 12 inches of rain in August while Milwaukee had only 5 inches in the same month. Both cities are within the Lake Michigan basin and the reporting stations are within 100 miles of each other. Meanwhile, Flint, which is in the Lake Huron basin, had a little less than an inch of rain in the same month. The unequal distribution of rainfall has been a problem for several months.

Secondly, soil moisture and interior streamflow remain well-below average in many areas of the Great Lakes, especially the eastern basins. This means that the rain that does fall can be absorbed and stored more readily by the ground and inland lakes. Hence, runoff is less likely to contribute quickly to a rise in the Great Lakes. Below-average streamflow over much of the upper Great Lakes is an excellent indicator of low ground water supply or "baseflow" to most streams and rivers across the basin.

Also, late summer and early fall are normally periods when water levels decline due to an increase in evaporation rates over the lake surface. Additional rainfall is needed just to compensate for the evaporative losses.

What is the recent forecast indicating to us about the condition of the watersheds?

Each lake forecast chart can tell a hidden story. For instance, there is a relatively wide range in the uncertainty bands of the lower lakes (Erie and Ontario) into February - March 2002. This wider range indicates that the next 4-6 months could be highly variable if rain and snow conditions are mild or severe.

Because of the alternating periods of heavy rain and drought so far in 2001, the central and eastern Great Lakes are at a critical crossroads in the hydrologic balance of the lakes.

A cool, dry fall would escalate evaporation since the surface lake temperatures are relatively warm; lake levels could go lower than the best estimate. Conversely, a severe cold fall and winter could slow or even stop seasonal declines by forming long-overdue ice cover on the lakes, reducing evaporation. If we receive a wet and cold winter, lake levels could rise above our best estimate since this would provide for reduced evaporation and much needed snowmelt next spring.

How does snowpack affect Great Lakes water supplies?

Snowmelt runoff is a significant factor in the spring supply of Great Lakes water. Up to 50% of Lake Superior's annual water supply comes from snowmelt runoff. Substantial snowmelt on the Lake Superior basin provides a long-term benefit to the Great Lakes because it eventually moves through the rest of the system.

Snowmelt runoff is ideal because:

- the ground is usually frozen, so much of the water runs off directly into streams and rivers;
- the melt is often slow but steady;
- conditions are cool enough that little water is lost to evaporation before reaching the lakes.

Because of the significant contribution that snowmelt runoff makes to the Great Lakes water supplies, the U.S. Army Corps of Engineers has been working with the U.S. National Weather Service (NWS) of the National Oceanic and Atmospheric Administration (NOAA) to measure snowpack water content over the Lake Superior basin for nearly 20 years.

The water level forecasts made in April of each year typically utilize these observations to provide invaluable outlooks for most of the open-water or boating season.

Is water temperature information used in the water level forecast?

Very much so. With the advancement of technologies, these data are easier to gather and distribute than ever before. One of the primary providers of these data is the Great Lakes Environmental Research Laboratory (GLERL) of NOAA in Ann Arbor, Michigan. For further insight on these data, please see their website at http://coastwatch.glerl.noaa.gov/statistic/).

Surface temperature data are collected by satellite images and displayed in various graphic forms by GLERL. NWS forecasters regularly visit this site during times of the year when warm or cold water temperatures could influence a coastal weather forecast.

Also, one of the Great Lakes hydrologic forecast models used in producing the coordinated forecasts distributed with this update article is GLERL's Advanced Hydrologic Prediction System (AHPS). The AHPS utilizes several meteorological variables to calculate water temperatures. Higher water temperatures roughly equate to greater surface evaporation losses; cooler temperatures mean less evaporative loss.

When the forecaster is deciding which model output to apply to the water level forecast, relative lake water temperature plays a key role in helping decide which outlook scenario to follow, and the expected response of the lake levels in the coming months.

We have had less than average snowpack across the upper Great Lakes the past few years – what is the outlook for this winter?

The NWS's Climatic Prediction Center is anticipating near-average temperatures and

precipitation through the fall, with average precipitation expected across all of the Great Lakes through the winter.

However, there is a strong indication of a colder-than-average winter across the upper Midwest and the Great Lakes region. If that pattern develops, we can anticipate above-average lake evaporation and lake-effect snows, with moderate, earlier than normal lake ice development. The snowpack should then be near average, but above average in the snowbelt regions around the lakes.

What impacts do low water levels have on the regulation decisions made for Lakes Superior and Ontario?

During periods of water level extremes, the IJC grants limited authority to the International St. Lawrence River Board of Control to make discretionary decisions on setting outflows other than those called for in the regulation plan for Lake Ontario. For the International Lake Superior Board of Control, discretionary deviation from prescribed regulation plan outflows very rarely occur.

One aspect of the outflow determination process is the employment of "systemic regulation". Ideally, flows should be regulated in such a manner as to achieve "levels relative to their long-term averages".

For example, if Lake Superior's level was closer to long-term average than it was to record lows, and Lakes Michigan-Huron's level was substantially below average, ideally, Lake Superior's outflows would be increased to bring those lakes into relative balance. However, this balancing relies on the continuation of ample water supplies to Lake Superior. If precipitation to the Lake Superior basin is inconsistent, outflows are reduced by the regulation plan to approximate pre-regulation conditions occurring prior to 1900.

Lake Ontario's situation is somewhat different, due to competing interests for water use. Adjusting outflows to balance variables such as lower flows from upstream lakes, ecological needs, and hydropower and navigation requirements demands frequent adjustment. As a result, lake levels and outflows through compensating structures are regularly monitored and adjusted frequently.

Since the Great Lakes water levels forecast continues to show below-average water levels into the winter, how much lower will the outflows from Superior and Ontario be?

Based on recent outflow history and the anticipation of near-average water level decline rates this fall, outflows from Lakes Superior should remain 2-5% below average in the St. Marys River and about 10% below average for the St. Lawrence River flowing from Lake Ontario.

What will it take to bring Great Lakes water levels back to normal?

Simply put, it would take at least 6 months of well-above-average precipitation across all of the Great Lakes watersheds to uniformly bring the levels back to near normal. However, because of the cascading nature of the Lakes system, the most beneficial location for consistently above-average precipitation would be on the Lakes Superior and Michigan-Huron watersheds.

Also, the Lakes Huron, Erie and Ontario watersheds would have to overcome relatively dry current soil conditions. After this is overcome, significant increases in streamflow would be needed for each of the lakes to rise substantially.